W-C FINAL REPORT

CHAPTER 7
OIL/WATER SEPARATORS

7.1 INTRODUCTION

Background

Oil/water Separators have limited application in stormwater treatment because their treatment mechanisms are not well-suited to the "wastewater" characteristics of stormwater runoff (i.e., highly variable flow with high discharge rates, turbulent flow regime, low oil concentration, high suspended solids concentration). In addition, separators can require intensive maintenance, further restricting their desirability as a stormwater treatment BMP.

Applicability

Oil/water separators should only be used in areas where oil spills are a concern, such as petroleum yards, and vehicle storage areas and/or maintenance yards. Field research has also shown that on-line oil/water separators have severe problems with resuspension of sediments and flushing of trapped floatables. Given their poor treatment performance, high cost , and existence of a proven alternative (i.e., sand filters), oil/water separators should not be used for stormwater runoff treatment. If an oil/water separator has to be used, it must be designed as off -line systems to handle up to a design flow rate **water quality design storm?**.

The primary use of oil/water separators will be in cases where oil spills are a concern, in which case a spill control (SC-type) separator may be specified. There will be but a few other cases where an oil/water separator would be required, as other BMPs are more appropriate for controlling oil. Source control in particular should be the first option and may negate the need for special treatment.

Land uses that must use an API or CPS-separator are identified in Chapter I-4 and in Chapter IV-2. The owner may choose between the API or CPS-separator using the design criteria outlined below. Other land uses or businesses should use the SC-separator for spill control as needed. There may be some cases that warrant the use of oil/water separators due to high vehicular traffic. These will have to be assessed on a case-by-case basis by the local government.

Alternative Solutions

Sand filtration and oil absorbent materials are being investigated as alternatives to oil/water separators . While there is very limited data on the effectiveness of sand filtration for treating oil, this practice does have an established record of treatment of other pollutants and effective treatment of oil may also be accomplished. Sand filtration is to be considered an alternative to oil/water separators on an interim basis until further data is collected. See Chapter III-3 for details on sand filtration BMPs.

Absorbent materials are another alternative whose use has been pioneered by METRO in King County. Widely used for controlling spills, these "pillows" have been installed in storm drain inlets as a mechanism to absorb free oil from surface water runoff. Limited data is available to assess their effectiveness and some operational problems have occurred. The disposal of these pillows once they are exhausted can be a problem as well.

III-7.2 PURPOSE AND SCOPE

The purpose of this chapter is to present general criteria for the evaluation, design and maintenance of oil/water separators. Because separators are usually manufactured units rather than constructed units, only limited details will be provided in this chapter. If oil/water separators are to be used, then an appropriate manufacturer or supplier should be contacted. Three types of oil/water separators are discussed in this chapter. Section III-7.4 applies to Spill Control (SC-type) Separators (BMP RO.05). Sections III-7.5 and III-7.6 cover API Separators (BMP RO.10) and Coalescing Plate Separators (CPS - BMP RO.15) respectively. See Figures III-7.1, III-7.2, and III-7.3 for illustrations of these BMPs.

For a useful discussion of oil treatment of stormwater runoff the reader is referred to the publication "Oil and Water Don't Mix: The Application of Oil-Water Separation Technologies in Stormwater Quality Management" (METRO, October, 1990).

III-7.3 GENERAL DESIGN CRITERIA

Ecology's effluent guideline requires that stormwater have no visible sheen, monthly average less than 10 mg/l and at no time exceed a daily maximum of 15 mg/l.

If an oil/water separator is used primarily for treatment (and not spill control), it should be located off-line from the primary conveyance/detention system. The contributing drainage area should be completely impervious and as small as necessary to contain the sources of oil. Non-source contributing areas only increase the size (and cost) of the separator and do not improve effectiveness. Under no circumstances should any portion of the contributing drainage area contain disturbed pervious areas which can be sources of sediment.

Oil droplets exist in water in a wide distribution of sizes. The separator therefore is sized to remove all droplets of a particular size and greater which will ensure that sufficient oil is removed to achieve the effluent standard. API-separators are usually sized to remove oil droplets 150 micron in size and larger. Smaller droplets rise so slowly as to require a relatively large vault. CPS-separators are commonly sized to remove 60 or 90 micron and larger oil droplets.

There are no data on the size distribution of dispersed oil in stormwater from commercial or industrial land uses with the exception of petroleum products storage terminals. These data indicate that by volume, about 80 percent of the droplets are greater than 90 micron. Less than 30 percent are greater than 150 microns. For this manual, both API and CPS-separators are sized to remove 60 microns and larger droplets at a temperature of

Figure III-7.1
SC-Type Separator

Figure III-7.2

API Separator

Figure III-7.3
CPS Separator

10° C giving a rise rate of 0.033 feet per minute. The requirement for treatment of 60 micron and larger sized droplets may preclude the use of API separators.

The design criteria discussed below applies to all three oil/water separators.

1. Separators should precede all other treatment and streambank erosion control BMPs.

2. Appropriate removal covers must be provided that allow access for observation and maintenance.

3. Stormwater from building rooftops and other impervious surfaces not likely to be contaminated by oil shall not discharge to the separator.

4. Any pump mechanism shall be installed downstream of the separator to prevent oil emulsification.

III-7.4 SC-TYPE SEPARATORS (BMP.RO 05)

Purpose and Definition

A spill control separator (SC) is a simple underground vault or manhole with a "T" outlet (Figure III-7.1). The SC-separator is effective at retaining only small spills and will not remove diluted oil droplets spread through the stormwater from oil-contaminated pavement.

Absorbent pillows can be used with SC-Type separators. They should be in the manhole/vault. Used adsorbent pillows will need to be disposed of properly.

III-7.5 API SEPARATORS (BMP.RO 10)

Purpose and Definition

The American Petroleum Institute (API) separator is a long vault or basin with baffles to improve the hydraulic conditions for treatment as shown in Figure III-7.2. Large API-separators may have sophisticated mechanical equipment for removing oil from the

surface and settled solids from the bottom. However, most applications will use the simple system as illustrated. This type of separator can be used to remove dispersed oil.

Design Criteria for API Separators

1. Separators are to be sized for the **water quality design storm?**. Larger storms shall not be allowed to enter the separator; the use of an isolation/diversion structure is recommended (see Chapter III-3 for details).

2. Separators shall have a forebay to collect floatables and the larger settleable solids. Its surface area shall not be less than 20 square feet (ft^2) per 10,000 ft^2 of the area draining to the separator.

3. If absorbent pillows are used with API separators, they should be in an afterbay. Used adsorbent pillows will need to be disposed of properly.

4. API-separators are sized using these general guidelines. These guidelines may be varied for individual situations based on manufacturer's recommendations or best professional judgement.

   - Horizontal velocity: 3 fpm or 15 times the rise rate whichever is smaller (rise rate of 0.033 ft/min is recommended)

   - Depth of 3 to 8 feet

   - Depth to width ratio of 0.3 to 0.5

   - Width of 6 to 16 feet

   - Baffle height to depth ratios of 0.85 for top baffles and 0.15 for bottom baffles

5. The separator is sized for depth using the equation:

Depth = $(Q/2V_h)^{1/2}$
where: Q = design flow (cfm)

V_h = design horizontal velocity (fpm) = 0.50 (15 times 0.033)

Calculate the width using the above ratios (i.e., 0.3 to 0.5 depth-to-width ratio).

Then calculate length using the equation:

$$\text{Length} = \frac{\text{Depth}}{\text{Rise Rate}} * V_h = \frac{(Q/2V_h)^{1/2}}{0.033} * 0.50 = \frac{(Q/2V_h)^{1/2}}{0.066}$$

III-7.6 CPS SEPARATOR (BMP.RO 15)

Purpose and Definition

The coalescing plate separator (CPS) contains a bundle of plates made of fiberglass or polypropylene. The plates are closely spaced. Depending on the manufacturer and/or application, the plates may be positioned in the bundle at an angle of 45 to 60° from the horizontal. This type of separator can be used to remove dispersed oil.

The closely spaced plates improve the hydraulic conditions in the CPS-separator promoting oil removal. The primary advantage of the CPS-separator is its ability to theoretically achieve equal removal efficiencies with one-fifth to one-half the space needed by the API separator, when designed to remove the same size droplets.

Design Criteria for CPS Separators

1. Separators are to be sized for the **water quality design storm?**. Larger storms shall not be allowed to enter the separator; the use of an isolation/diversion structure is recommended (see Chapter III-3 for details).

2. Separators shall have a forebay to collect floatables and the larger settleable solids. Its surface area shall not be less than 20 square feet (ft^2) per 10,000 ft^2 of the area draining to the separator.

3. Plates shall not be less than 3/4 inch apart.

4. The angle of the plates shall be from 45° to 60° from the horizontal.

5. If absorbent pillows are used with CPS separators, they should be in an afterbay. Used adsorbent pillows will need to be disposed of properly.

6. For CPS-separator sizing, calculate the projected (horizontal) surface area of plates required using the following equation:

$$A_p = \frac{Q}{\text{Rise Rate}}$$

Where A_p = projected surface area of the plate ($ft.^2$); note that the actual surface area,

$A_a = A_p$ / cosine H

H = angle of the plates with the horizontal in degrees, usually varies from 45-60 degrees.

Q = design flow (cfm).

Rise rate - recommend using 0.033 ft/min.

7. Manufacturers of plate packs provide standard size packages which are rated at a particular flow (usually in gpm). However, as the manufacturer's flow rating is for conditions different than used above, the engineer must compare the plate surface area with the above calculation. Do not confuse the projected plate area with actual plate area (see Figure III-7.4). The width, depth, and length of the plate pack and the chamber in which the plate pack is placed is completely flexible and is a function of the plate sizes provided by the particular pack manufacturer and standard size vaults that are available for small sites.

Figure 15.4 Cross-Section of CPS Oil/Water Separator

III-7.7 CONSTRUCTION AND MAINTENANCE CRITERIA

Construction Criteria

There are no special construction considerations.

Maintenance Criteria

1. Oil/water separators must be cleaned frequently to keep accumulated oil from escaping during storms. They must always be cleaned by October 15 to remove material that has accumulated during the dry season, and again after a significant storm.

2. The facility shall be inspected weekly by the owner.

3. Oil absorbent pads are to be replaced as needed but shall always be replaced in the fall prior to the wet season and in the spring.

4. The effluent shutoff valve is to be closed during cleaning operations.

5. Waste oil and residuals shall be disposed in accordance with current local government Health Department requirements.

6. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at a discharge location approved by the local government.

7. Any standing water removed shall be replaced with clean water to prevent oil carry-over through the outlet weir or orifice.